

Determining the Burden of Human Illness from foodborne diseases: CDC's Emerging Infectious Disease Program Foodborne Disease Active Surveillance Network (FoodNet).

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Food borne diseases are common; it is estimated that between 6.5 and 33 million cases occur each year in the United States⁹. Although most of these infections cause mild illness, severe infections and serious complications-including death-do occur. The public health challenges of food borne diseases are changing rapidly as a result of newly identified pathogens and vehicles of transmission, changes in food production, and an apparent decline in food safety awareness. The sources of our food supply in a global economy have become increasingly complex; rapid transport of perishable goods and consumer preferences for new types and sources of food has led, in many instances, to exposure to food borne pathogens from distant parts of the United States and the world. Increased demand for ready-to-eat and minimally processed foods as well as increased dining in restaurants has also contributed to the new epidemiology of food borne disease. For example, food borne disease outbreaks of Salmonella and Escherichia coli O157:H7 infections have been associated with an increasingly wide variety of foods, including some previously thought to be safe, such as alfalfa sprouts and unpasteurized fruit juice.^{3, 4, 5, 10} Responding to these new food borne disease challenges requires surveillance to monitor the incidence of human illness, which will, in turn, provide data necessary for planning and developing effective prevention strategies.?

NATIONAL SURVEILLANCE SYSTEM FOR FOOD BORNE DISEASE

There are several types of national surveillance systems for food borne diseases, including outbreak surveillance, passive laboratory based surveillance of individual cases, physician-based surveillance, and active surveillance. Many of the data about vehicles and modes of transmission of food borne disease come from outbreak investigations. Food borne disease outbreaks investigated by state and local health departments are reported to the Centers for Disease Control and Prevention (CDC) through the Foodborne Outbreak Surveillance System. Because only a small proportion of food borne disease outbreaks are recognized, investigated, and reported to CDC, the value of this database is the qualitative description of food vehicles and modes of transmissions for common enteric pathogens. Only about 500 outbreaks, with approximately 20,000 cases of food borne disease, are reported to CDC each year.

Although information about food borne disease outbreaks is useful, the majority of cases of food borne disease in the United States are sporadic, meaning they are apparently unrelated to other cases geographically or temporally. All 50 state public health laboratories electronically report culture-confirmed cases of Salmonella, Shigella, and several other food borne pathogens to the CDC using the Public Health Laboratory Information System (PHLIS). This surveillance system is considered a passive system: it relies on clinical laboratories to refer isolates to local or state

health departments, who then report them to CDC. Most cases of food borne illness are not identified or reported through this passive surveillance system. For the system to function, the ill person must have symptoms severe enough to seek medical care, the physician must order a bacterial stool culture, the microbiology laboratory must culture the organism and refer the isolate or report positive results to local or state health departments, and these departments must report the case to CDC (Fig. 1).



Figure 1. The burden of illness pyramid. Passive surveillance data represent only the tip of the iceberg. FoodNet is designed to collect information along each step of this pyramid.

If any of these steps do not occur, the case of food borne illness is not reported through passive surveillance systems; it is estimated that only 5% of bacterial food borne illness is reported to the CDC by this system.

FOODNET ACTIVE SURVEILLANCE

The CDC/USDA/FDA Food borne Diseases Active Surveillance Network (FoodNet) was designed to determine more precisely the burden of food borne illness in the United States through active surveillance and related studies. As the principal food borne disease component of the CDC's Emerging Infections Program (EIP), FoodNet is a collaborative project among the CDC, the participating EIP sites, the U .S. Department of Agriculture (USDA), and the U.S. Food and Drug Administration (FDA).² FoodNet was established in 1995 in five locations: Minnesota, Oregon, and selected counties in Georgia, California, and Connecticut, and has expanded to selected counties in Maryland and New York in 1997. The total population of these sites, or catchment areas, is 19.2 million people, or 7.5% of the population of the United States (Fig. 2).

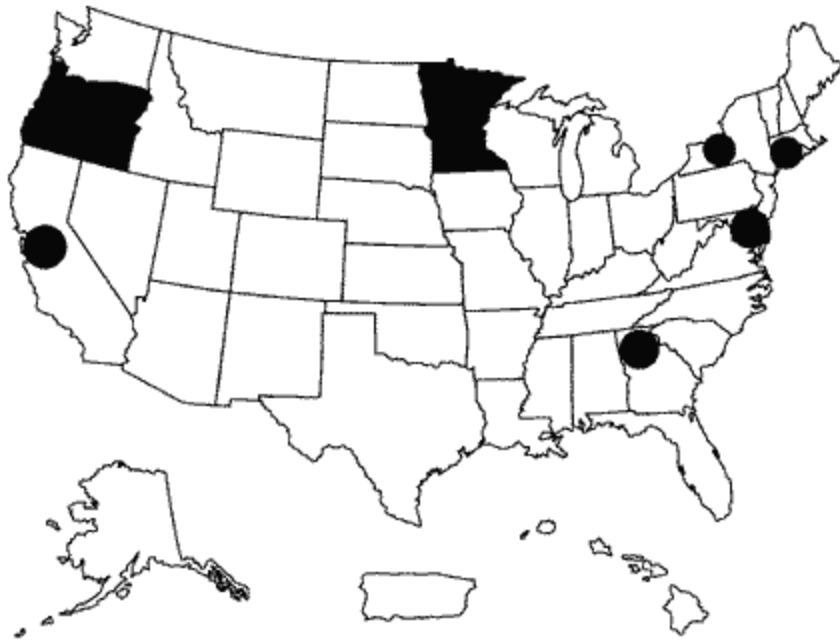


Figure 2. FoodNet sites in Minnesota, Oregon, and selected counties in California (San Francisco and Alameda), Connecticut (Hartford, New Haven, and Fairfield), Georgia (Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, Dekalb, Douglas, Fayette, Forsythe, Fulton, Gwinnett, Henry, Newton, Pauline, Pickens, Rockdale, Spaulding, Walton), Maryland (Anne Arundel, Baltimore, Baltimore City, Carroll, Harford, Howard), and New York (Monroe, Wayne, Genessee, Ontario, Orleans, Livingston, and Yates). The total population of these sites is 19.2 million persons, or 7.5% of the United States population.

The objectives of FoodNet are to provide a network for responding to new and emerging bacterial, parasitic, and viral food borne diseases of national importance, to more precisely determine the frequency and severity of food borne diseases that occur in the United States, and to identify the source of specific food borne diseases. By monitoring the burden of food borne illness over time, FoodNet will help to determine if new food safety initiatives, such as USDA Pathogen Reduction and HACCP Rule, are effective in decreasing the number of cases of food borne disease in the United States each year. Information gained through this network will also lead to new interventions and prevention strategies for addressing the public health problem of food borne diseases.

FoodNet is an active, population-based surveillance system. Public health officials contact microbiology laboratories on a regular basis to collect information on all culture-confirmed cases of food borne diseases. Data are collected from all (over 300) clinical microbiology laboratories that test stool samples in the participating sites; therefore, the total number of culture-confirmed cases that occur in these populations can be determined. Since January 1996, information has been collected on culture-confirmed cases of *Salmonella*, *Shigella*, *Campylobacter*, *E. coli* 0157:H7, *Listeria*, *Yersinia*, and *Vibrio* infections among residents of the catchment areas of

the five original sites; this information is transmitted electronically to the CDC. The result is a comprehensive and timely database of food borne illness in a well-defined population. Data from 1996 surveillance has shown dramatic regional variation in the rates of pathogens (Fig. 3).

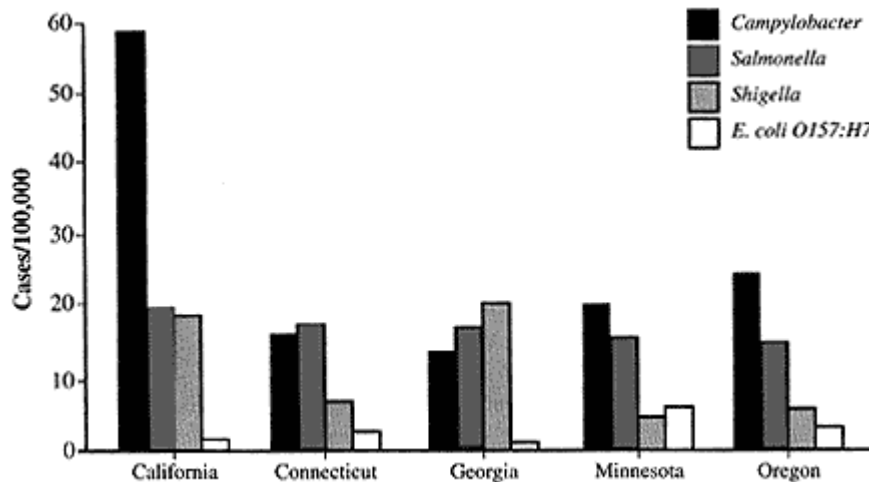


Figure 3. Annual incidence (per 100,000 population) of laboratory confirmed cases of *Campylobacter*, *Salmonella*, *Shigella*, and *E. coli* O157:H7 infections, by selected sites, 1996. (From Anonymous: Food borne disease active surveillance network, 1996. MMWR 46:258-261, 1997; with permission.)

For example, among FoodNet sites there is an increased rate of *Campylobacter* infections in California, an increased rate of *E. coli* O157:H7 infection in Minnesota, and increased rates of *Shigella* infections in California and Georgia. Although the rate of salmonellosis is similar among sites, there is regional variation by serotype; Georgia has a high rate of *Salmonella* serotype Typhimurium and Connecticut has a high rate of *Salmonella* Enteritidis when compared to other FoodNet sites.

Evaluation and interpretation of these variations in the rates of food borne diseases require additional information about each step in the reporting chain of the food borne disease pyramid. Interpretation of active surveillance data requires knowledge of laboratory practices because the number of isolates reported is affected by the proportion of laboratories that culture for a particular pathogen. Physicians play a crucial role in surveillance for food borne diseases. The number of culture-confirmed cases is affected by the proportion of physicians that either request stool samples for testing from patients with diarrhea or fail to request testing for a specific pathogen that is not routinely cultured for in the laboratory receiving the specimen. As changes occur in the way health care is provided in the United States, stool culturing practices also may change over time. Finally, to be able to estimate the burden of food borne disease based on active surveillance data, it is necessary to determine how often persons with diarrhea seek medical care. These three additional surveys of laboratory practices, physician culturing practices, and care seeking behaviors among persons who are ill with diarrhea will assist in determining the true burden of illness in the

population.

To determine laboratory culturing practices, FoodNet investigators conducted a baseline laboratory survey of all microbiologic laboratories in the catchment areas to determine which pathogens are included in routine bacterial stool cultures, which tests must be specifically requested by the physician, what specific techniques are used to isolate the pathogens, and the methods used to collect and examine specimens. All clinical laboratories routinely culture stool specimens for *Salmonella*, *Shigella*, and *Campylobacter*; however, only 34 % (range of 13%-52%) of stool specimens were routinely cultured for *Yersinia enterocolitica*, 20% (range of 9%-43%) for *Vibrio*, and 47% (range of 6%-82%) for *E. coli* O157:H7. Overall, 80% (range of 58%-99%) of bloody stool specimens were cultured for *E. coli* O157:H7.

To obtain information on physician stool culturing practices, a questionnaire was mailed to 5000 physicians during 1996. Data collected included specialty, practice setting, detailed information regarding the last diarrheal patient seen, and whether this patient provided a stool specimen for bacterial culture. In the future, FoodNet will continue to monitor-by surveys and validation studies-the practices of physicians who send stool samples to laboratories within the catchment areas.

The FoodNet population survey is an essential part of active surveillance for food borne illness because it allows for an estimate of the population who seek medical care when affected by diarrheal illness. Using a methodology similar to the CDC Behavioral Risk Factor Surveillance System, 11 surveys of randomly selected residents in the catchment areas have been done to determine the incidence of self reported diarrheal illness in the population and the proportion of those with diarrhea who seek medical care for the illness. Additional exposure data are collected, including information regarding consumption of foods known to have caused outbreaks of food borne illness. During 1996, 750 residents of the catchment areas were interviewed by telephone each month (9000 per year) .

To determine the causes of sporadic food borne disease for two pathogens, FoodNet conducted case-control studies of *E. coli* O157 and *Salmonella* serogroup B (includes *S. Typhimurium*) and D (includes *S. Enteritidis*) infections in 1996. More than 60% of *Salmonella* infections in the United States are caused by these two serogroups. The case-control studies will provide better information about which food items or other exposures may cause these infections. The *Salmonella* and *E. coli* O157:H7 laboratory specimens from these patients are sent from FoodNet sites to CDC for further study, including antibiotic resistance testing, phage typing, and molecular subtyping by pulsed-field gel electrophoresis.

FoodNet has also provided the infrastructure for conducting active surveillance for new and emerging diseases. When an association between bovine spongiform encephalopathy in cattle and variant-Creutzfeldt-Jakob disease in humans was suspected in the United Kingdom, EIP personnel conducted surveillance for this rare human disease and also collaborated in the investigation of a multistate outbreak of *Cyclospora* infections associated with consumption of raspberries from Guatemala.

Since becoming operational on January 1, 1996, the CDC's EIP FoodNet has begun tracking the rates of food borne diseases. FoodNet also has contributed to the detection of outbreaks. In 1996, FoodNet collaborators detected an outbreak of *Salmonella* infections caused by contaminated alfalfa sprouts in Oregon, and two

outbreaks of *E. coli* O157:H7 infections were detected in Connecticut, one due to lettuce and one due to apple cider.⁶ Other 1997 projects include a focus on *Campylobacter*, with a case-control study to determine the risk factors for infection and determination of antibiotic resistance patterns among *Campylobacter* strains. Collaborative FoodNet investigators also have established active surveillance for hemolytic uremic syndrome (HUS), a serious complication of *E. coli* O157:H7 infection.

In the future, FoodNet will continue to monitor the burden and causes of food borne disease in the seven population-based sites. Additional surveys of laboratories, physicians, and population will be conducted to allow interpretation of surveillance trends and extrapolation of data from the culture-confirmed cases to the true burden of illness in the population and to monitor this burden over time.

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